Determination

under the

Building Act 1991

No. 93/005: Spread of fire in the enclosure of a swimming pool

1. The matter to be determined

1.1 General

1.1.1 The matter before the Authority was a dispute over a territorial authority's refusal to issue a building consent in respect of the construction of an enclosure over an existing swimming pool on the grounds that the safeguards against fire spread did not comply with clause C3.2 of the New Zealand Building Code (the First Schedule to the Building Regulations 1992).

1.1.2 The narrow question is whether exposed insulation material on the walls and ceiling should be covered by a flame barrier. Pending this determination, construction has proceeded under a building consent for building work to the stage where a flame barrier will be provided if so determined.

1.2 The building

1.2.1 The plans submitted to the Authority show that the enclosure is to consist of exposed laminated timber portal frames with exposed timber purlins supporting an insulating layer of sheets of a proprietary brand of extruded polystyrene containing a flame retardant under galvanised steel cladding.

1.2.2 An existing filter room and an existing floor will be inside the enclosure. Existing buildings will abut each end of the enclosure. An office, a club room, changing rooms, and storage rooms in those buildings will open into the enclosure. Ceiling ventilation domes will be provided to those rooms. The remainder of the existing building at one end of the enclosure is identified as being "sheds" and "public toilets", which open to the outside and have no openings into the rooms that open into the enclosure.

1.2.3 The enclosure will have a mechanical ventilation system supplying fresh air, so that the enclosure is without openings except for doors and ventilation louvres.

1.3 The submissions

1.3.1 The parties' submissions consist of the relevant parts of the application for building consent and subsequent correspondence between the parties.

1.3.2 The applicant submits:

(a) Fire engineering calculations showing that:

(i) "a large fire would need to be developed before the general room temperature reached 300°C [the melting point of the polystyrene]", and

(ii) a 400kW fire in a corner or a 1,600kW fire in the open would be needed to cause melting immediately above the fire, and fires of twice those intensities would be necessary "to cause melting at a radial distance of 1.5m from directly above the fire".

(b) That the building has a "very low potential fire load which we estimate to be well below 500MJ/m^2" and will therefore contain insufficient fuel for even a 400kW fire to develop. Even if fuel were deliberately brought into the building and lit "it is unreasonable to assume that such an effort will occur unnoticed while the pool is occupied".

(c) The polystyrene without a flame barrier "will not prevent escape of occupants in a reasonable time".

(d) "If a large fire has been deliberately lit and is well developed before the arrival of the fire service it is conceivable that access for the fire fighters may be restricted due to melting of the ceiling material. Such a situation will be obvious to the fire fighters however. Furthermore, it is unlikely that they would be able to, or wish to, enter the building with the fire so well developed. Due to the type of building materials (light cladding, laminated timber frames) any fire which engulfs the total building will be of relatively short duration."

(e) "The total occupant load is ... calculated at 205 people ... Three exitways are provided to keep within the open path requirement of 30m. All dead ends are less than 12m."

1.3.3 The territorial authority submits the advice it received from the New Zealand Fire Service to the effect that:

(a) The applicant's calculations are incorrect because:

(i) They do not take proper account of fire ventilation and heat conduction through walls and ceilings.

The applicant responded to this point by saying that its calculations were approximate only and were intended to show that "a significant quantity of fuel" would be required to develop sufficient heat for the polystyrene to become a special hazard.

(ii) The melting point of the polystyrene is not 300°C but 150°C.

(b) From the Service's own analysis "it can be determined that an upper layer temperature of 150°C occurs before 330s after the start of the fire and 300°C occurs before 540s".

The applicant responded to this point by saying that the Service's "calculated time of 330s as being the beginnings of any development of special risk ... is only 20% of the calculated egress time for 205 normally abled persons to evacuate through any two of the three provided escape paths (based on 75 metres per minute horizontal travel and 60 persons per minute passing through each door leaf)". The Authority takes this to mean that the applicant's calculated egress time is 66s, not the 1,650s of which 330s is 20%.

2. Discussion

2.1 General

2.1.1 The narrow point at issue is whether the polystyrene insulation should be protected by a flame barrier in order to comply with the New Zealand Building Code. The New Zealand Building Code contains no specific requirement for a flame barrier, but it is a requirement of Approved Document C3/AS 1. That Approved Document is not, of course, the only means of establishing compliance with the New Zealand Building Code, but it may be taken into account as a guide to such compliance.

2.1.2 The reason for requiring a flame barrier is that the rate of heat release from the polystyrene insulation in a fire depends on the amount of air available. The presence of a flame barrier reduces the air supply to the polystyrene and therefore the rate of heat release from it.

2.1.3 The relevant provisions of the New Zealand Building Code are:

"C3.2 *Buildings* shall be provided with safeguards against *fire* spread so that:

"(a) Occupants have time to escape to a *safe place* without being overcome by the effects of *fire*,

"(b) Firefighters may undertake rescue operations and protect property";

and

"C3.3.1 Interior surface finishes on walls, floors, ceilings and suspended *building elements* shall resist the spread of *fire* and limit the generation of toxic gases, smoke and heat, to a degree appropriate to:

"(a) The *travel distance*,

"(b) The number of occupants,

"(c) The *fire hazard*".

2.2 Numbers of occupants

2.2.1 The Authority considers that the applicant has underestimated the number of people likely to be present in the building at any one time in the following respects:

(a) The plans submitted to the Authority show that future seating could be provided for well in excess of the 75 people assumed by the applicant.

(b) The applicant has assumed that an area of 40m^2 "could accommodate 40 people", but the Authority considers that the area concerned could accommodate 72 people at the "occupant density" of 1.8 users/m^2 for stadia and grandstands given in Table A2 of the Appendix to Approved Documents C2, C3, C4. The Authority also considers that the area concerned is not the only area available for spectators.

2.2.2 Accordingly, the Authority considers that at least 300 people are likely to be present in the building at any one time.

2.3 Fire hazard

2.3.1 The Authority considers that the applicant has underestimated the fire hazard, and particularly the fire load or amount of combustible contents which can reasonably be expected to burn within the building if a fire does start. In particular:

(a) Immediately around the pool there are likely to be a significant amount of combustible items such as shelves and the like for clothing, notice boards, flotation aids, kayaks, spare bulkheads, starting blocks, lane markers, and possibly decorative flags and banners.

(b) If some of those items are not in the immediate pool area they are likely to be in the store rooms, which will probably also contain combustible cleaning materials and equipment.

(c) The normal range of combustible contents are likely to be present in the office and club room.

(d) Wooden seating, partitions, and other joinery are likely to be installed in the changing rooms, and swimmers' clothing will also contribute to the fuel load.

(e) The timber structure and framing constitute a significant amount of fuel (almost five times as much as the polystyrene itself).

(f) There is no way of telling what will be in the sheds. Although there are no doors from the sheds to the changing room, there is no fire rated separation between them.

2.3.2 Accordingly, the Authority considers that because of the size and nature of the likely fire load the applicant's fire engineering calculations should have included the scenario of a "fast fire" on the pool surrounds or in one of the existing buildings with flames issuing from openings and reaching the ceiling. By a "fast fire" is meant a fire that reaches a size of lMW in 150s as distinct from a "moderate fire" which reaches lMW in 300s. A fast fire typically results from the burning of polystyrene and of wood or reconstituted wood panels.

2.4 Escape time

2.4.1 The Authority considers that the applicant has underestimated the "escape to exit" times in that:

(a) The time of response of people in the building will be longer than for other types of building such as offices and factories.

(b) People in the pool itself have to swim to the pool edge and climb out before they can walk to an exit.

(c) Many swimmers would want to go back to the changing rooms to reclaim their clothes, towels, and valuables before escaping.

(d) People in the showers would not wish to go to the exits naked but would wish to dry and clothe themselves first.

(e) People who run on wet pool surrounds frequently slip and injure themselves (and in an emergency block the route of others), and many swimming pools have notices "Walk, don't run".

(f) On many occasions the people present will include a high proportion of children unaccompanied by adults.

2.4.2 Accordingly, the Authority considers that the escape time should be assumed to be at least 150s (2½ minutes).

2.5 Firefighting operations

2.5.1 The Authority has been advised by the New Zealand Fire Service that "Given also that the likely Fire Service response time is some 20 minutes it can be seen that the entire space and contents will be involved on arrival".

2.5.2 The provision of a flame barrier would delay the rate of early development of the fire over the first few minutes (see 2.6.4 below) but would not affect the size of the developed fire that the Service would have to contend with after 20 minutes.

2.5.3 With a 20 minute response time, it is unlikely that firefighting operations would be affected by the presence or absence of a flame barrier.

2.6 Fire calculations

2.6.1 The Authority considers that the applicant's calculations were inappropriate because they:

(a) Used a heat loss fraction of 0.9 which is appropriate to an uninsulated building, whereas 0.6 would have been more appropriate for this insulated building.

(b) Assumed that the walls and ceilings would not contribute to the fire until flashover, whereas it would have been more appropriate to consider the case of the walls and ceiling (including parts of the timber frames and purlins and adjacent polystyrene) contributing to a "fast" fire on the pool surrounds or in one of the existing buildings with flames issuing from openings and reaching the ceiling.

2.6.2 The Authority considers that the melting point for polystyrene should be taken as 150°C not 300°C as assumed by the applicant. Gaseous and combustible decomposition products develop from the melt at temperatures in excess of 200°C.

2.6.3 The Authority considers that the critical tenability limit for occupants is when the temperature in the smoke layer reaches 183°C. At that temperature the smoke layer represents an overhead radiator of about 25kW/m^2, which is enough to ignite hair and clothing of people below the layer.

2.6.4 The Authority considers that in this particular building the 183°C limit will be reached in approximately:

(a) 3½ minutes with no flame barrier and a fast fire at floor level;

(b) 6 minutes with no flame barrier and a moderate fire at floor level;

(c) 6 minutes with a flame barrier and a fast fire at floor level;

(d) 11 minutes with a flame barrier and a moderate fire at floor level.

3. Conclusions

3.1 The Authority concludes that the design should include for a "fast" fire on the pool surrounds or in one of the existing buildings with flames issuing from openings and reaching the ceiling. In that case the tenability level will be reached in approximately 3½ minutes. The Authority considers that the calculated time of 3½ minutes would provide an inadequate margin of safety in conjunction with the assumed escape time of 2½ minutes.

3.2 Thus the Authority concludes that the polystyrene material without a flame barrier on both walls and ceiling does not provide sufficient safeguard against fire spread for the occupants to have time to escape.

3.3 However, the Authority does not consider that it is necessary to provide a flame barrier over all of the polystyrene material in the ceiling, it will be sufficient if the flame barrier is provided on the walls and on that part of the ceiling that is above the pool surround and that part of the pool within 1.5m horizontally of the edge of the pool.

3.4 The Authority took account of the provisions of clause C3.2(b) of the New Zealand Building Code regarding firefighters undertaking rescue operations. It concludes that with a flame barrier installed as described in 3.3 above, the firefighters' ability to undertake rescue operations will not be compromised.

4. The Authority's decision

4.1 In accordance with section 20(a) of the Building Act the Authority hereby confirms the territorial authority's decision to refuse a building consent for the building to be completed without a flame barrier protecting the polystyrene insulation on the walls and ceilings.

4.2 The Authority determines that the necessary building consent is to be issued to complete the enclosure with a flame barrier to the satisfaction of the territorial authority protecting the polystyrene insulation on:

(a) The walls; and

(b) That part of the ceiling that extends in plan from the line of the walls to 1.5m beyond the edge of the pool.

Signed for and on behalf of the Building Industry Authority on this 22nd day of November 1993

J H Hunt
Chief Executive